Spray Drift & Worker Exposure

Worker Exposure to Chemical Solution as Effected by Application Method

Environmental Fate of Herbicides

Angela R. Post
Extension Weed Scientist
What is Environmental Fate?

- Simple definition: what happens to the herbicide after it leaves the sprayer

Fate of a herbicide

- Persist
- Degrade
- Move

Persist
- How long a herbicide stays intact in the environment.
- Long Persistence
  - Good for weed control
  - Not good for the environment. The longer it persists, the more likely it is to move off site.

How long do herbicides persist
- Depends on the properties of the herbicide

Half-life. Amount of time it takes a herbicide to reach one-half (1/2) of the originally applied concentration. Expressed in days, weeks, months, years.

Persistence—Herbicide ½ Life

Small changes can make big differences

Preemergence Herbicides – Avg. t-1/2

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Soil Persistence t-1/2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrazine</td>
<td>60 d</td>
</tr>
<tr>
<td>Bensulide</td>
<td>120 d</td>
</tr>
<tr>
<td>Isoxaben</td>
<td>50 - 120 d</td>
</tr>
<tr>
<td>Pronamide</td>
<td>60 d</td>
</tr>
<tr>
<td>Metolachor</td>
<td>15 - 50 d</td>
</tr>
<tr>
<td>Simazine</td>
<td>60 d</td>
</tr>
<tr>
<td>Metribuzin</td>
<td>14 - 28 d</td>
</tr>
</tbody>
</table>

Postemergence Herbicides – Avg. t-1/2

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Soil Persistence</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4-D</td>
<td>10 d</td>
</tr>
<tr>
<td>2,4-DP</td>
<td>10 d</td>
</tr>
<tr>
<td>MCPA</td>
<td>6 d</td>
</tr>
<tr>
<td>MCPP</td>
<td>21 d</td>
</tr>
<tr>
<td>Dicamba</td>
<td>21 - 84 d</td>
</tr>
<tr>
<td>Triclopyr</td>
<td>10 - 46 d</td>
</tr>
<tr>
<td>Clopyralid</td>
<td>40 d</td>
</tr>
</tbody>
</table>
Persistence

- May persist by adsorption
  - Adsorption: the association of molecules with the surfaces of solids.
  - Depends on the properties of the herbicide and the soil

Soil Components

- Solid phase (sand, silt, clay, humus – decayed organic matter)
- Liquid phase (water held in soil spaces)
- Gaseous phase (air in soil spaces)
- Biological phase (bacteria, fungi, protozoa, algae, animals)

Herbicide adsorption

- The herbicide is broken down and no longer possess herbicidal activity
- Processes include:
  - Microbial – deactivated by soil microbes
  - Hydrolysis – reaction with water
  - Photolysis – deactivated by light

Degradation

- The herbicide is broken down and no longer possess herbicidal activity
- Processes include:
  - Microbial – deactivated by soil microbes
  - Hydrolysis – reaction with water
  - Photolysis – deactivated by light

Given time, the molecule becomes CO₂
Microbial
- Herbicide broken down by microorganisms
- Fungi and bacteria
- Warm, moist conditions increase degradation

Photolysis
- Herbicide broken down by light
- This is why fluridone (Sonar) will persist longer in muddy water.

Hydrolysis
- Herbicide broken down by water
- After mixing in the tank
- After application in soil water

Movement
- If degradation is slow, the more opportunity the herbicide will move off-site
  - Runoff – surface water contamination
  - Leaching – ground water contamination
  - Volatility – non-target injury

Runoff
- Runoff occurs when the amount of rainfall of irrigation exceeds the normal infiltration rate

Runoff – lateral movement
Why did this happen? They sprayed an off-label herbicide that is highly persistent and mobile.

Movement–Leaching

- Leaching is when a herbicide moves deep into the soil as water moves through the soil.

- Why would a herbicide leach?
  - Low clay and organic matter content in soil
  - Highly water soluble herbicide
  - Doesn’t bind tightly to soil
  - Long soil persistence

Movement–Volutility

- Volatilization–The change from a liquid or solid to a gas

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Vapor pressure (mm Hg)</th>
<th>Relative Volatility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluridone (Sonar, etc.)</td>
<td>$1 \times 10^{-7}$</td>
<td>Very low</td>
</tr>
<tr>
<td>Glyphosate</td>
<td>$1 \times 10^{-7}$</td>
<td>Very low</td>
</tr>
<tr>
<td>Imazapyr (Habitat)</td>
<td>$2 \times 10^{-7}$</td>
<td>Very low</td>
</tr>
<tr>
<td>Triclopyr amine (Garlon 3A)</td>
<td>$3 \times 10^{-7}$</td>
<td>Very low</td>
</tr>
<tr>
<td>Triclopyr ester (Garlon 4)</td>
<td>$3 \times 10^{-6}$</td>
<td>Low</td>
</tr>
<tr>
<td>2,4-D amine</td>
<td>$8 \times 10^{-6}$</td>
<td>Low</td>
</tr>
<tr>
<td>2,4-D ester</td>
<td>$1 \times 10^{-2}$</td>
<td>Very high</td>
</tr>
<tr>
<td>Dicamba (Veteran)</td>
<td>$9 \times 10^{-6}$</td>
<td>Low</td>
</tr>
</tbody>
</table>

- In general, pesticides are volatilized from plant surfaces to a greater extent and faster than from the soil.
- Volatilization continues for from a few days to several weeks (or sometimes even more), occasionally displaying a diurnal cycle.
- May lose 10 to 90% of applied dose over course of season.

Conclusions

- Herbicides can persist, degrade, or move in a landscape depending on the properties of the chemical and the environment.
- Most of the herbicides we use today have a relatively short life in the environment.
- If they are found to persist too long, they will not be granted registration by EPA.
- Degradation of a herbicide in the environment occurs by microbes, light, or chemical reactions in the water.